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Professor Waltraud M. Kriven

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Materials Science and Engineering Dept., University of Illinois at Urbana-Champaign,
1304 W. Green St.,
Urbana IL 61801
Tel: (217) 333 5258
Fax: (217) 333 2736
Email: kriven@uiuc.edu

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Dr. Joan Fuller
Ceramic and Non-Metallic Materials Program Manager
Directorate of Aerospace and Materials Engineering
Air Force Office of Scientific Research
4015 Wilson Blvd, room 713
Arlington, VA 22203-1977
Ph. (703) 696 7236

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14. ABSTRACT

The Marksman Fiber Drawing Machine, (Chemat Technology Inc., Northridge, CA) is a research scale, positive displacement, piston-type, fiber extruder. The machine was custom made to extrude various compositions of fibers from polymeric precursors specifically designed with sufficient flexibility to cover anticipated research requirements. It has a capacity of 10-150 grams, offers operational temperatures up to 500°C, a 10 – 10,000 m/min take up capacity, and 2400 Watts heater capacity. It allows the continuous drawing of fiber while the diameter of the spinnerette hole can be designed to fit application requirements. Standard spinnerette orifice diameters of 200 nm, 150 nm and 100 nm were supplied. In addition, an orifice diameter of 30 nm was custom made for research use. The machine for UIUC was custom made with an integrated high temperature furnace to allow the fiber to be dried and sintered at elevated temperatures, in three zones, up to 1,200°C with programmable controls.

15. SUBJECT TERMS
Fiber extruder, polycrystalline powders, 200nm to 30 nm orifice

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a. REPORT	b. ABSTRACT	c. THIS PAGE		4	Prof. Waltraud Kriven
					19b. TELEPHONE NUMBER (include area code) (217º 333 5258

Description of Instrument

The Marksman Fiber Drawing Machine, (Chemat Technology Inc., Northridge, CA) is a research scale, positive displacement, piston-type, fiber extruder. The machine was custom made to extrude various compositions of fibers from polymeric precursors specifically designed with sufficient flexibility to cover anticipated research requirements. It has a capacity of 10-150 grams, offers operational temperatures up to 500°C, a 10 – 10,000 m/min take up capacity, and 2400 Watts heater capacity. It allows the continuous drawing of fiber while the diameter of the spinnerette hole can be designed to fit application requirements. Standard spinnerette orifice diameters of 200 nm, 150 nm and 100 nm were supplied. In addition, an orifice diameter of 30 nm was custom made for our research use. The machine for UIUC was custom made with an integrated high temperature furnace to allow the fiber to be dried and sintered at elevated temperatures, in three zones, up to 1,200°C with programmable controls. Fig. 1 shows the complete fiber extruder assembled in our laboratory. Fig. 2 focuses on the take up spool at the foot of the stand and beneath the heating furnace.

Status of Extruded Fibers

Polycrystalline mullite monofilaments were prepared by the extrusion method. Extrusion was carried out in our new fiber extruder. The orifice for extrusion was varied from 30 μm to 250 μm. Hydrothermally grown KM mullite powder (KM Mullite 101, Kyoritsu Ceramic Materials Co. LTD., Nagoya, Japan) was used as starting powder. The composition of the powder consisted of 60 mol% Al_2O_3 and 40 mol% SiO_2 and the average particle size was 0.77 μm.

PVA and methyl cellulose were used as a binder for extrusion. 15 wt% of PVA (Polyvinyl Alcohol, Airvol 540S, Celanese Chemicals, USA) solution in DI water was prepared as PVA binder. Also 3 wt% of cellulose (Hydroxypropyl Methyl Cellulose, Sigma-Aldrich, Milwaukee, WI) binder was added. The prepared mullite powder was mixed with the organic binder to create a paste for extrusion. The mixed paste was loaded in the fiber extruder and mullite fiber was extruded. The speed of the piston during extrusion was controlled in order to form a uniform diameter of fiber (Fig. 3). The extruded fibers were dried in air and sintered at various temperatures up to 1600 °C. The microstructure of sintered fiber was characterized by scanning electron microscopy (Zeiss DSM960 SEM).

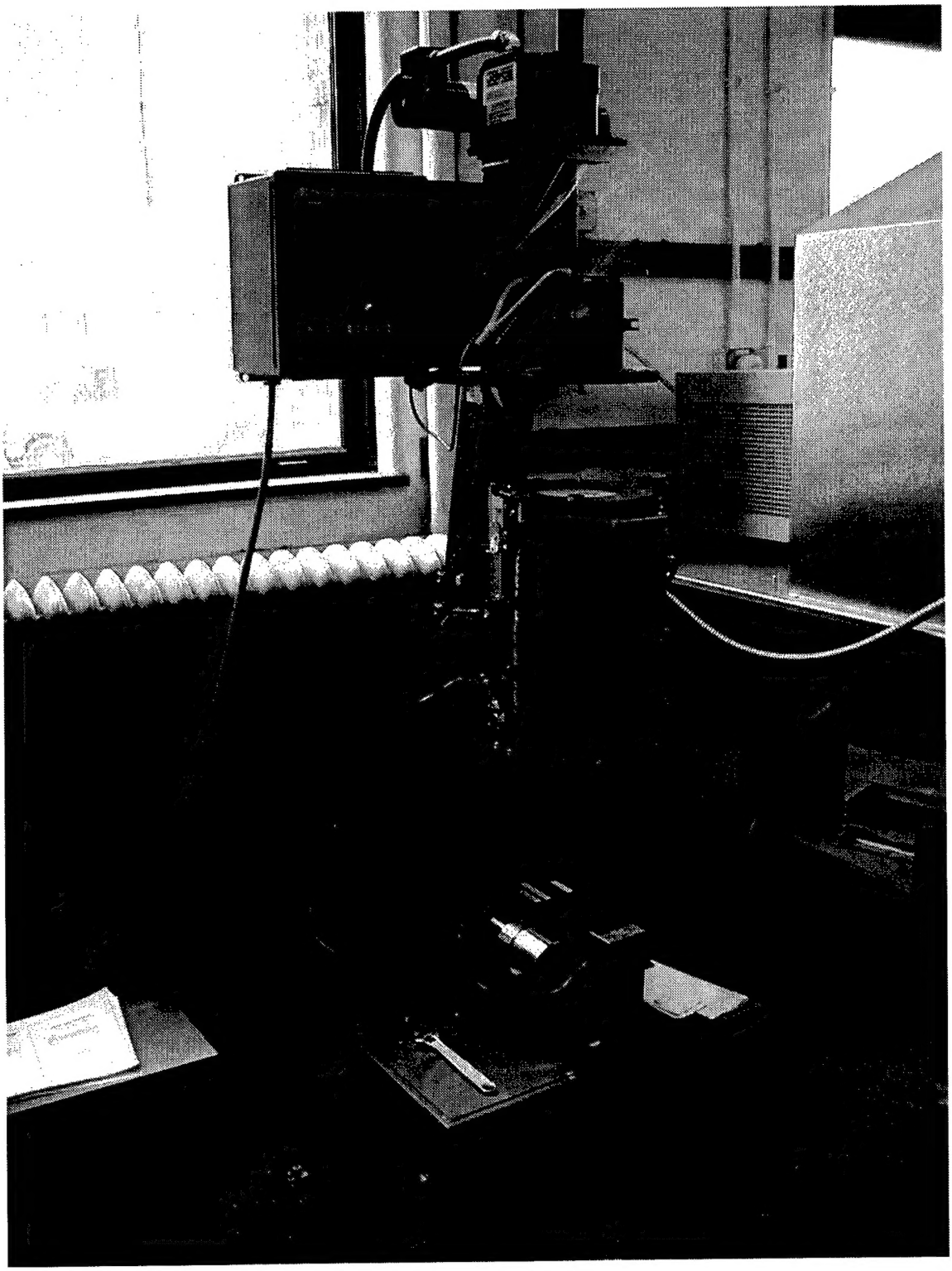

Fig. 1 Photograph of complete Marksman fiber extruder set up at UIUC

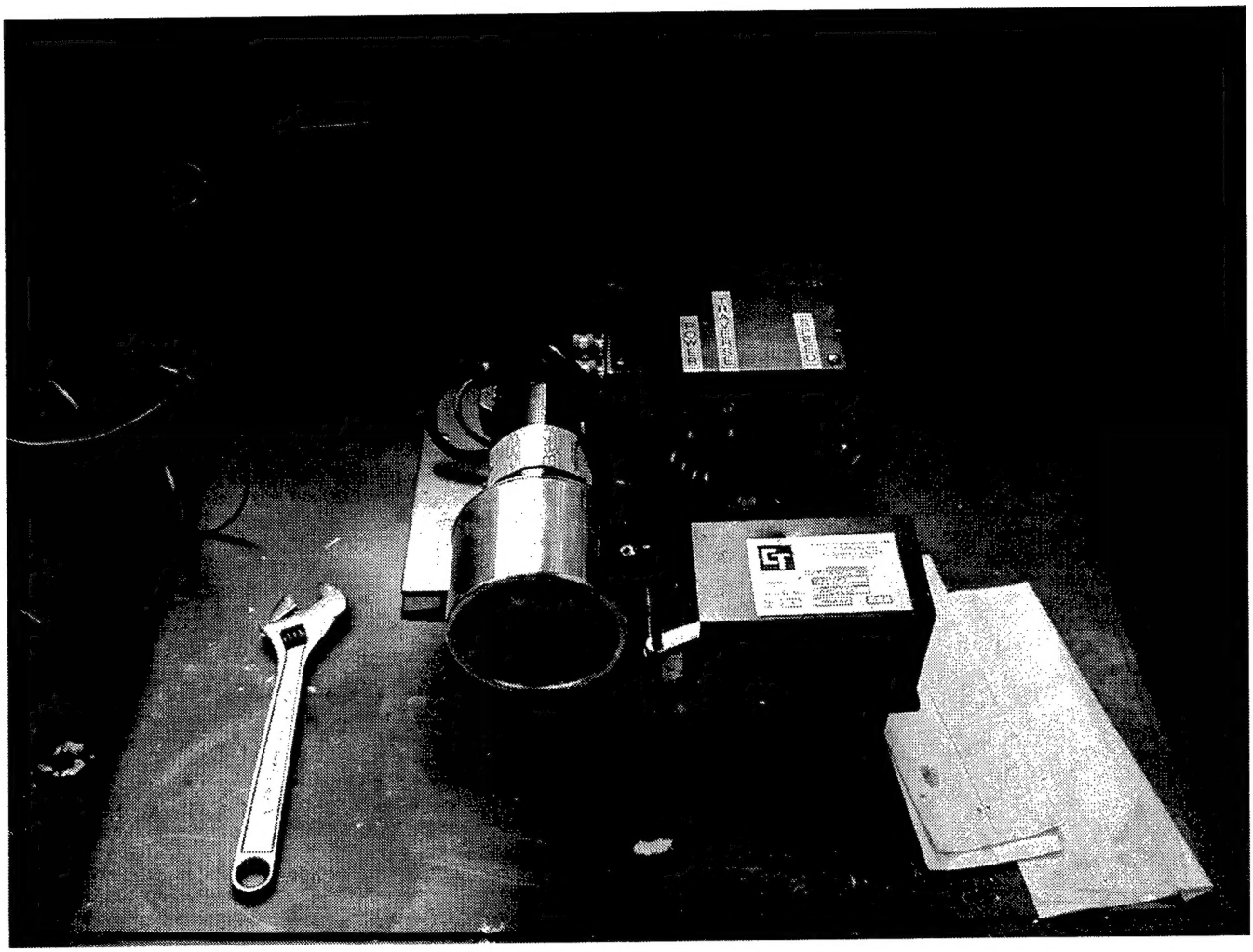

Fig. 2. The take up spool of the Marksman fiber extruder

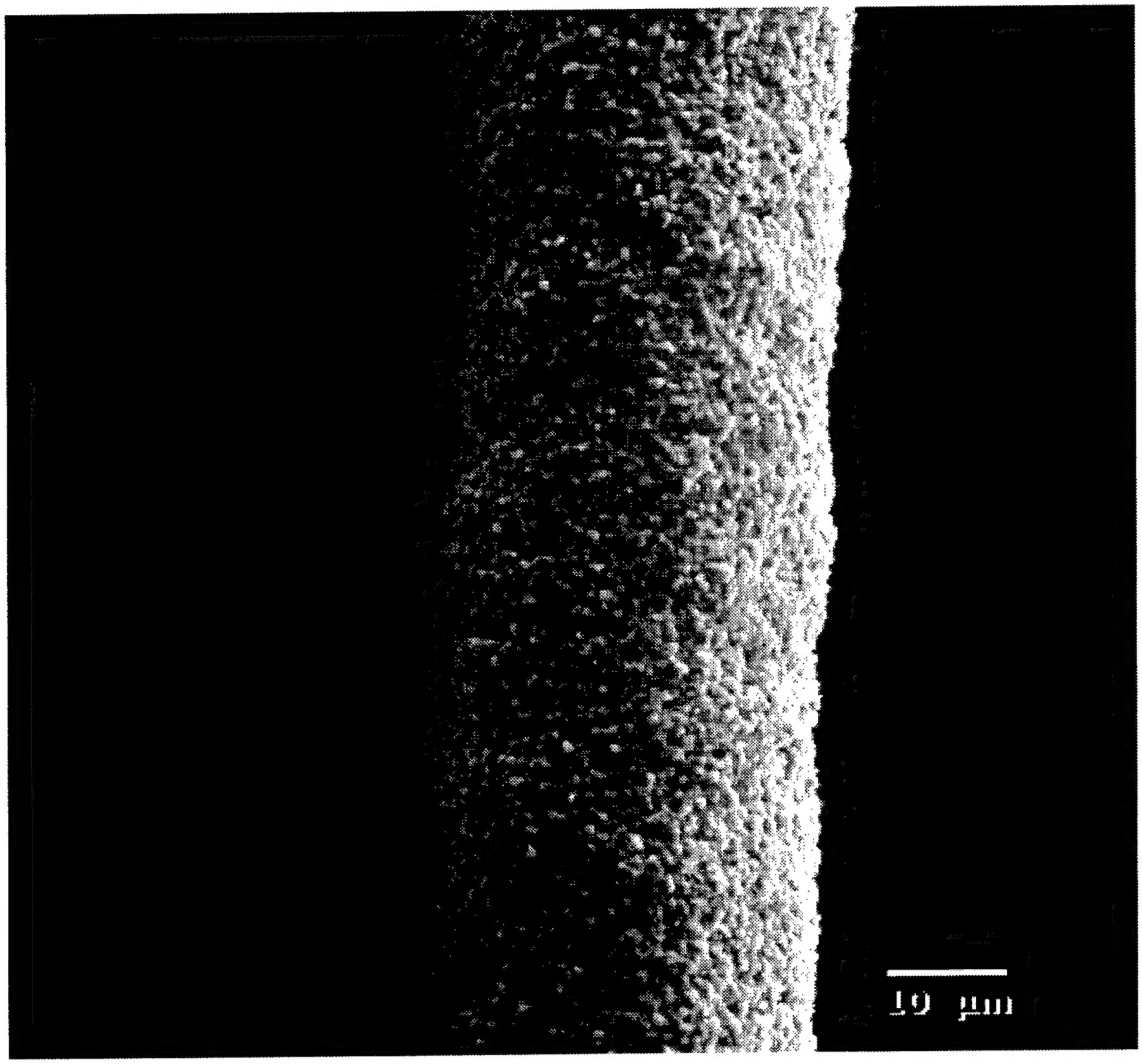

Figure 3 Mullite fiber drawn with the Marksman extruder and sinterered at (1600 °C/1hr). This fiber will now be passed through the quadrupole furnace at an optimized temperature and traverse rate.